

Geographers divide the Earth system into four major parts. Each part is called a sphere because it occupies a shell around the planet. The **atmosphere** is the envelope of gases that surrounds Earth. It is the least dense and outermost sphere, extending from Earth's surface into space. Earth's gravity holds the atmosphere around the planet. About 78 percent of Earth's atmosphere is a gas called nitrogen, and about 21 percent is oxygen. The rest is made up of carbon dioxide, ozone, and other gases. These gases and water vapor sustain life on Earth. The atmosphere also protects the planet from the Sun's harmful radiation.

The **lithosphere** is the solid crust of the planet. This outer crust includes rocks and soil. It forms Earth's continents, islands, and ocean floors.

The **hydrosphere** is all of Earth's water. Water covers about 70 percent of Earth's surface. The hydrosphere includes water in liquid, solid, and gaseous forms. Liquid water is found in oceans, lakes, rivers, and underground. Clouds and fog are made up of liquid droplets. Solid water, or ice, is found on both land and sea. Large amounts of ice are locked in glaciers in the polar regions. Earth is the only planet in the solar system known to have large amounts of surface water. Water is essential to all living organisms.

The **biosphere** is the part of Earth that includes all life forms. It includes all plants and animals. The biosphere overlaps the other three spheres. It extends from deep ocean floors to high in the atmosphere.

Earth's four major spheres are all interconnected. Each one affects the other. For example, the hydrosphere supplies people with water, which we need to live. It is also a home for plants and animals. The hydrosphere affects the lithosphere when rain breaks up rocks and washes them away. It also constantly interacts with the atmosphere, causing clouds and rain.

✓ **READING CHECK:** *Physical Systems* How are Earth's four spheres different from each other?

## Earth's Environment

Earth's four spheres make up the **environment**, or surroundings. The environment includes all the biological, chemical, and physical conditions that interact and affect life. Within our solar system, no other planet has an environment as complex as Earth's. Our closest neighbors, Venus and Mars, each have an atmosphere and a lithosphere. However, neither has a vast supply of liquid water. In recent years, scientists have looked far into space. They have discovered many other stars that have planets. In fact, scientists have found more than 50 planets outside our solar system. Do you think there is another planet in the universe that has the right environmental conditions for life?



*Earth's atmosphere from space*



*Earth's lithosphere—a volcano in Hawaii*



*Earth's hydrosphere—waves off the Oregon coast*



*Earth's biosphere—a rain forest in New Zealand*



# Geography for Life

## Ice Ages and the Earth System

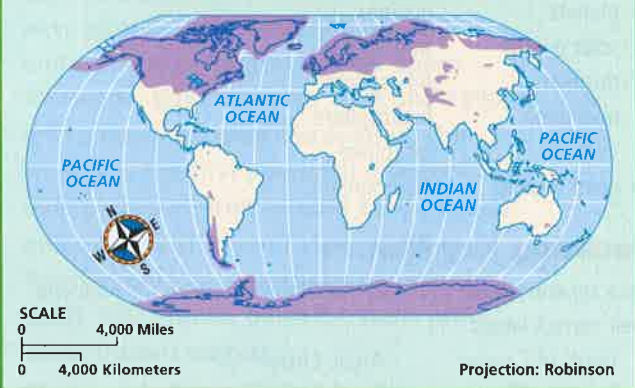
Throughout this textbook you will read about the forces and processes that have shaped the Earth system. Among the most important of these processes were Earth's ice ages. Ice ages are long periods of time during which thick ice sheets cover vast areas of land. During the ice ages, Earth's temperatures cooled for thousands or even millions of years, and ice sheets spread across the planet. During the most recent ice age, which ended about 10,000 years ago, ice sheets covered almost one third of Earth's present land area. (See the map of Pleistocene Glaciation.) Earth is currently experiencing a warm period between ice ages.

Ice ages greatly affect Earth's hydrosphere. For example, water from the oceans is frozen and locked in the expanding ice sheets. During the most recent ice age, enough water was frozen to lower global sea levels some 300 to 400 feet (90 to 120 m). As a result, more land was exposed at Earth's surface. The shapes and locations of coastlines differed greatly from how they look today. For example, the British Isles and mainland Europe were connected. North America and Asia were joined across what is now the Bering Strait. Rising ocean waters eventually covered those land bridges, however. Ocean levels rose because the warm period between ice ages causes ice to melt and ocean levels to rise. In fact, this process is partly responsible for the gradual rise in ocean levels today.

Some of the effects that ice ages have had on Earth's landscapes are easy to see. Slowly moving ice sheets carved and scraped the lithosphere, removing soil and forming holes. When the ice melted some of these holes filled with water and became lakes and swamps. The Great Lakes were formed in this way. Moving ice also wore down mountains and created great valleys.

In addition to their effects on the hydrosphere and lithosphere, ice ages also affected Earth's atmosphere and biosphere. Colder temperatures caused shifts in wind patterns. Ice-age temperature changes also caused a major redistribution of plants and

### Pleistocene Glaciation



**INTERPRETING THE MAP** The most recent ice age occurred mainly during the Pleistocene Epoch. This epoch began about 2 million years ago and ended about 10,000 years ago. Therefore, this ice age is known as the Pleistocene Ice Age, or Pleistocene Glaciation. During the Pleistocene Glaciation there were perhaps 12–16 periods of major ice advances. Between these cold periods were warmer times called interglacials. **Which parts of the world were covered with ice during the Pleistocene Glaciation?**

animals. For example, expanding ice shifted the habitats of plant and animal species in the Northern Hemisphere from north to south. As a result, many species died off. During the last ice age, the distribution of human populations also changed. Most researchers believe that a land bridge across the Bering Strait allowed humans to move from eastern Asia to the Americas. Humans also moved across land links between areas in Europe, Asia, and Australia.

### Applying What You Know

- Summarizing** In what ways did ice ages affect the Earth system? How can some of those effects be seen today?
- Analyzing Information** In what ways might a new ice age affect Earth's biosphere?